GLAST Large Area Telescope

Calorimeter Subsystem

5.3 CDE Manufacturing

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CEA responsibilities

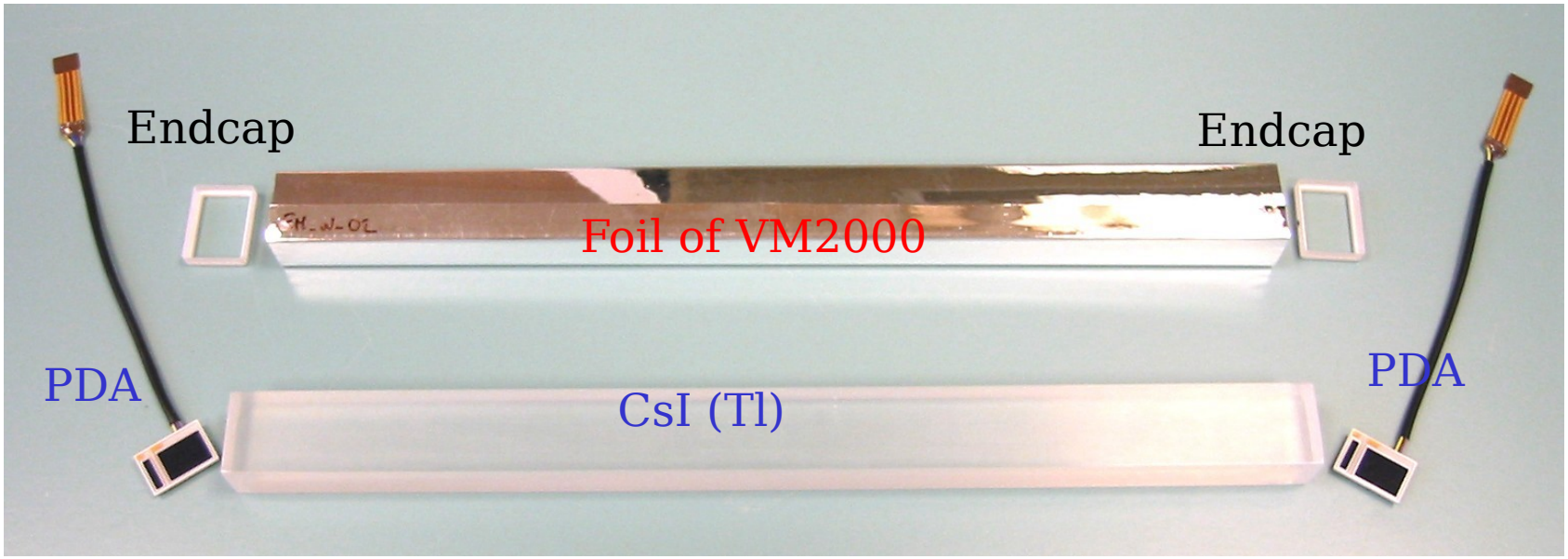
Design and development of the CDE including :

- **CDE process specification (written & sent for call for tender Feb'03)**
- **shared procurement, with the U.S., of DPDs to a common specification (1800 DPD from CEA–Hamamatsu-France proposition Mar'03)**
- **DPD testing (done for EM-DPDs)**
- **procurement of DPD wires, attachment and testing of the PDA (diode-cable assemblies),**
- **bonding of PDA to the Crystals and process qualification,**
- **procurement of wrapping material, crystal wrapping, and process qualification,**
- **acceptance testing of finished CDE**

Program status

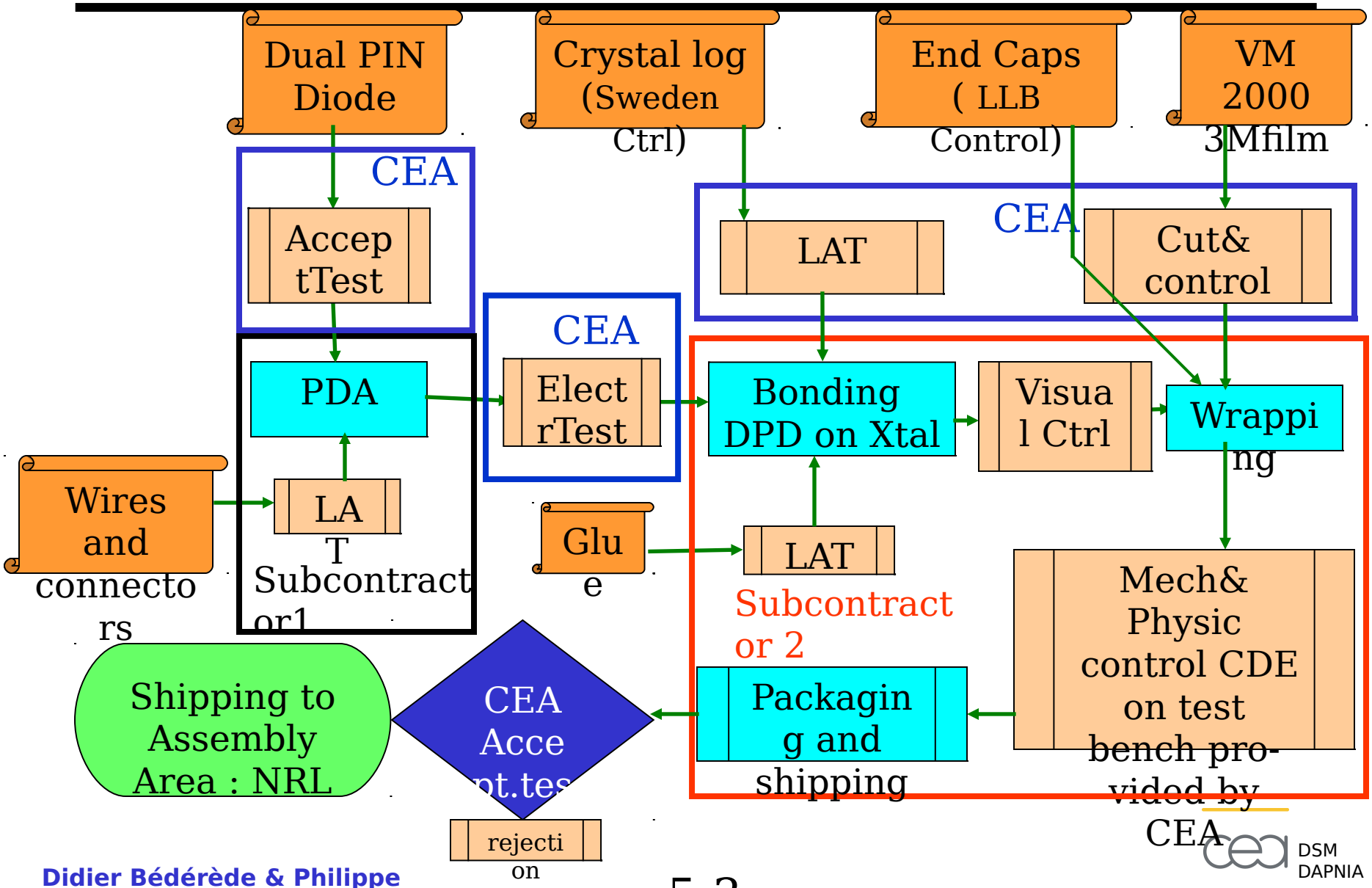
- LoA between NASA and CNES
  - final draft approved by both parties, almost signed
- MoA between SLAC, NRL, CEA:
  - signed in Jan'03
- Financial agreement between CNES and CEA:
  - budget & manpower profiles approved in Nov'02
  - new CNES financial situation: participation to GLAST recommended to the President, but cost-capped
- 14 EM-CDEs delivered to NRL in Dec'03
  - they meet the specifications & performance
  - bonding on DPD (epoxy window) & tooling design demonstrated
  - packing concept evaluated
  - DPD evaluation failed (epoxy window at low T + pin corrosion) ⇒ new DPD
  - flex changed to wires at the CAL level
- present activities
  - evaluation of the new DPD, new PDA and new PDA bonding
  - placing contracts for the FM PDA, CDE, GSE, & various containers

CDE Overview



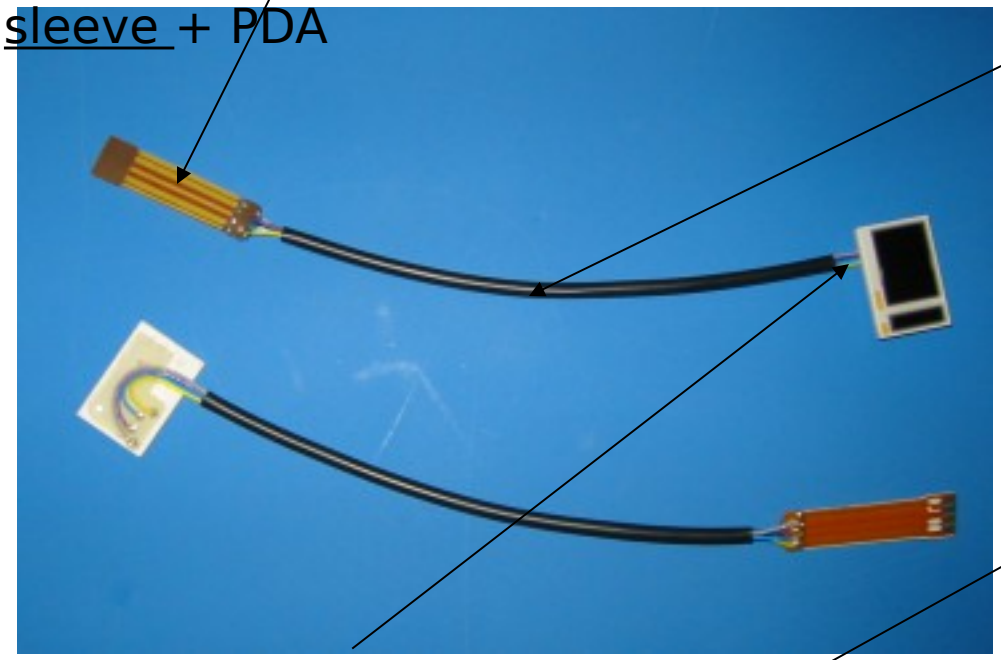
- **a CDE consists of :**
  - **1 cristal log of CsI doped with Thallium provided and tested by Sweden**
  - **2 PDA (DPD with wires), one bonded to each end**
  - **wrapping consisting of one molded foil of VM2000 and 2 white endcaps provided and controlled by LLR**

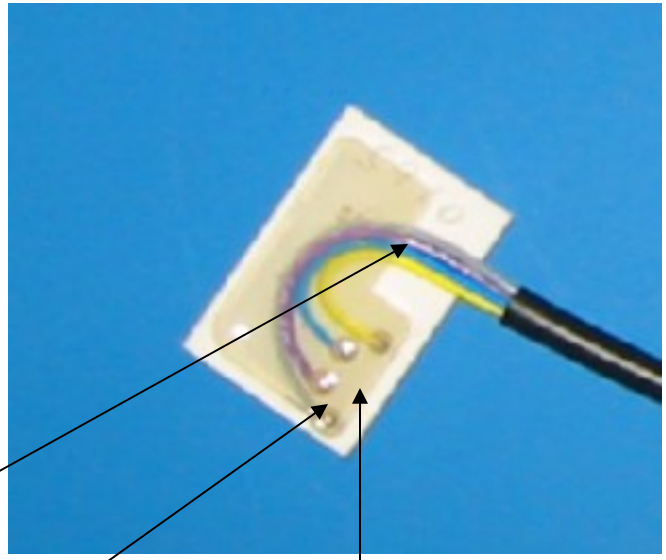
Manufacturing Plan



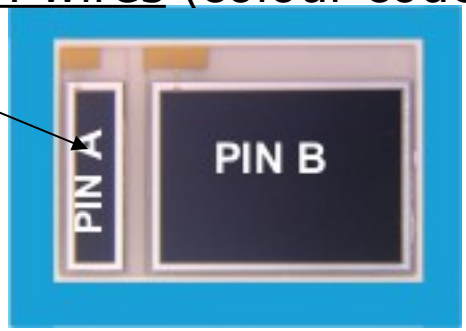
PDA overview

PDAfr = Connector for all French acceptance tests + Protective sleeve + PDA





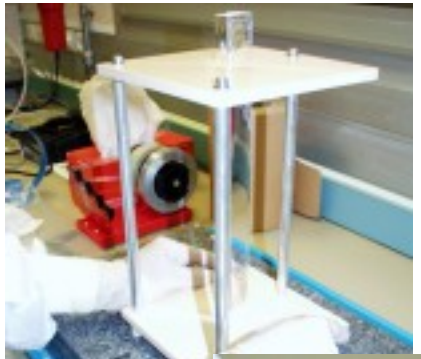
PDA = Dual Pin Diode +4 wires (colour coded) soldered on pins+ staking



PDA manufacturing plan

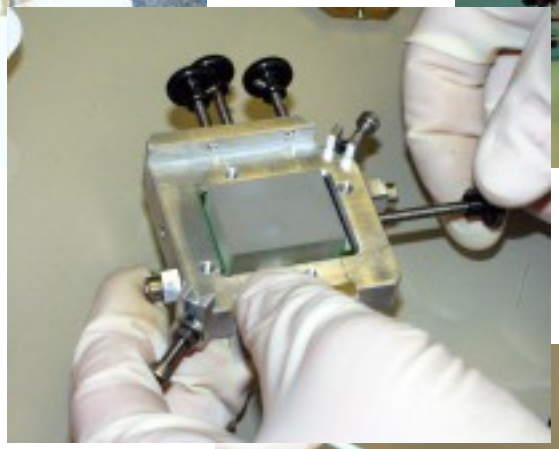
- Because of the short schedule: wire procurement before contract (> 8 weeks to manufacture)
- Contract Order: foreseen May 21
  - Call for tender : done (6 companies interested)
  - Sending specifications to selected companies (mid March)
  - Answers from the companies: (end April)
  - Opening letters and ask for additional information
  - Write & sign the contract and place the order
- Preparation &training (molding tools, encapsulant product…)
  7 weeks
- Manufacturing lot 1 of 264 PDA (begin. July to begin. Aug)
- Manufacturing lot 2 of 240 PDA (in August)
- Manufacturing lots 3 to 20 (240 PDA /2 weeks)

PDA-Crystal Bonding Process Overview

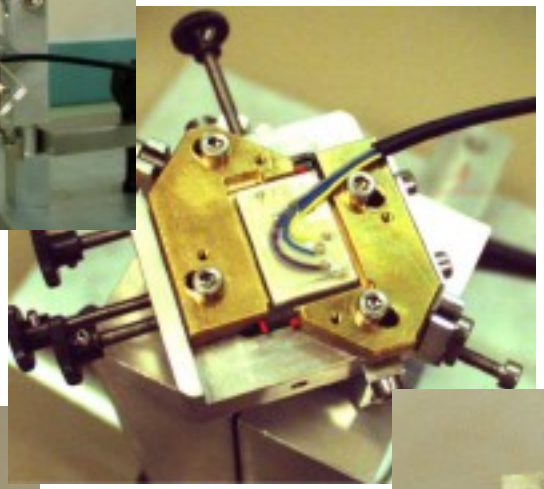


End face polishing

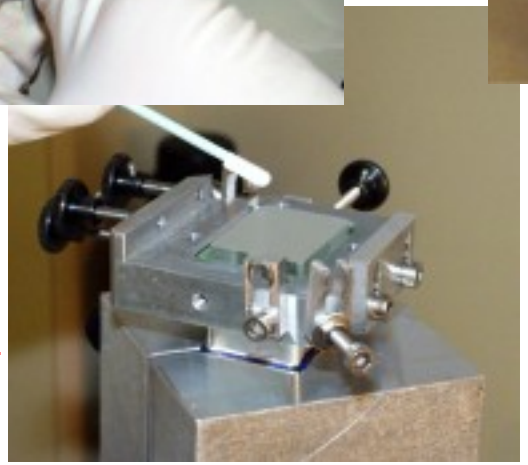
Mold tooling & Glue injection



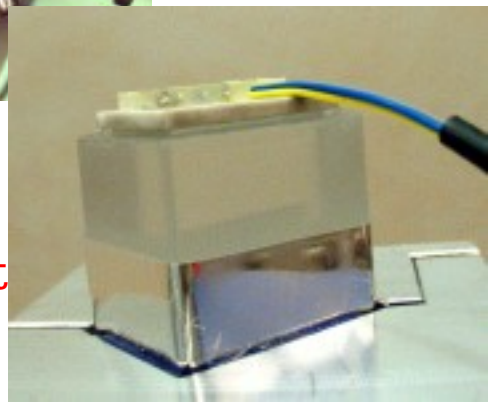
Support tooling



Mold removal after 24 hours



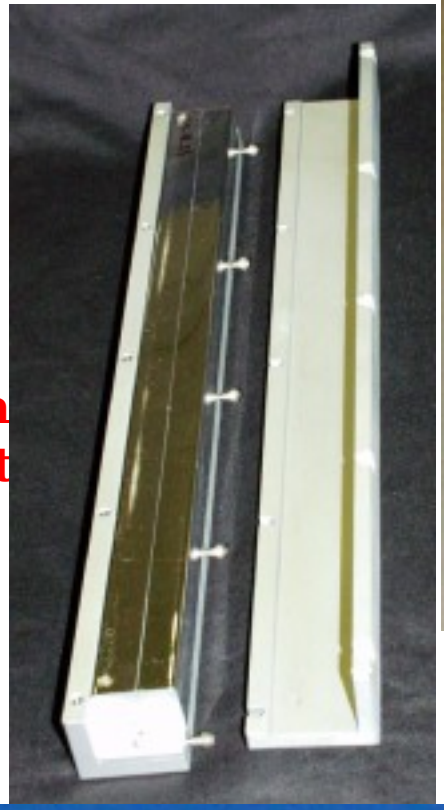
Primer deposition

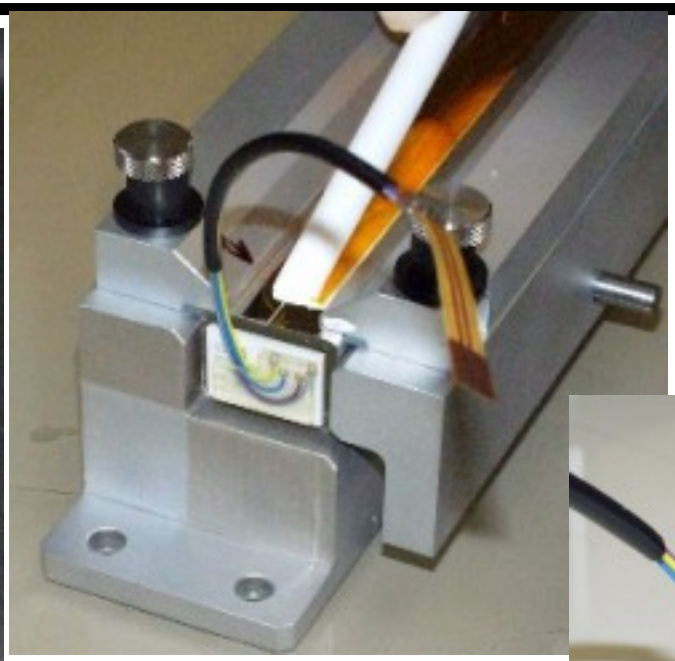


Polymerisation time = 7 days

Wrapping overview

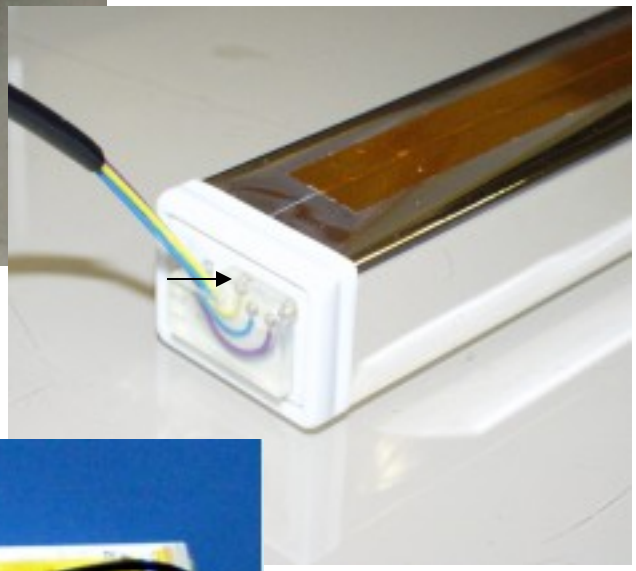
VM2000 foil shaped around a kernel at 120°C

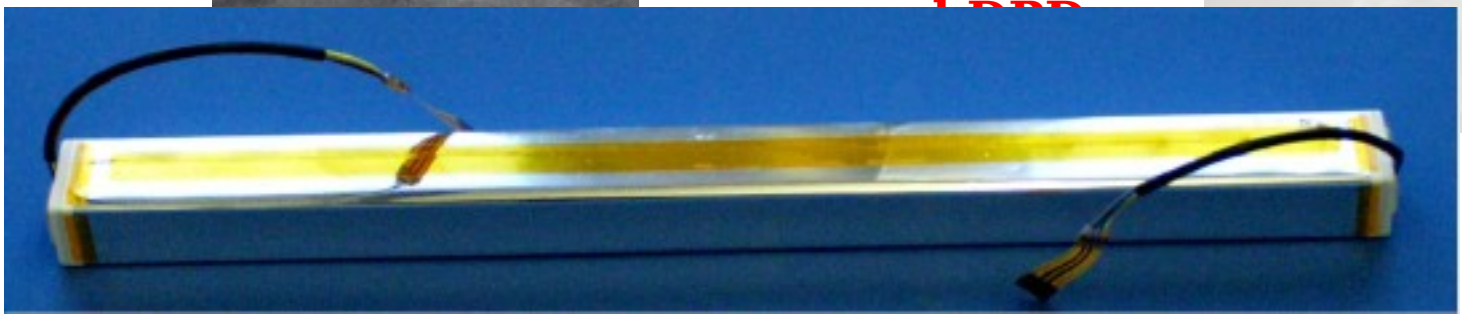




VM2000 foil wrapped and pasted

Mounting of the end cap

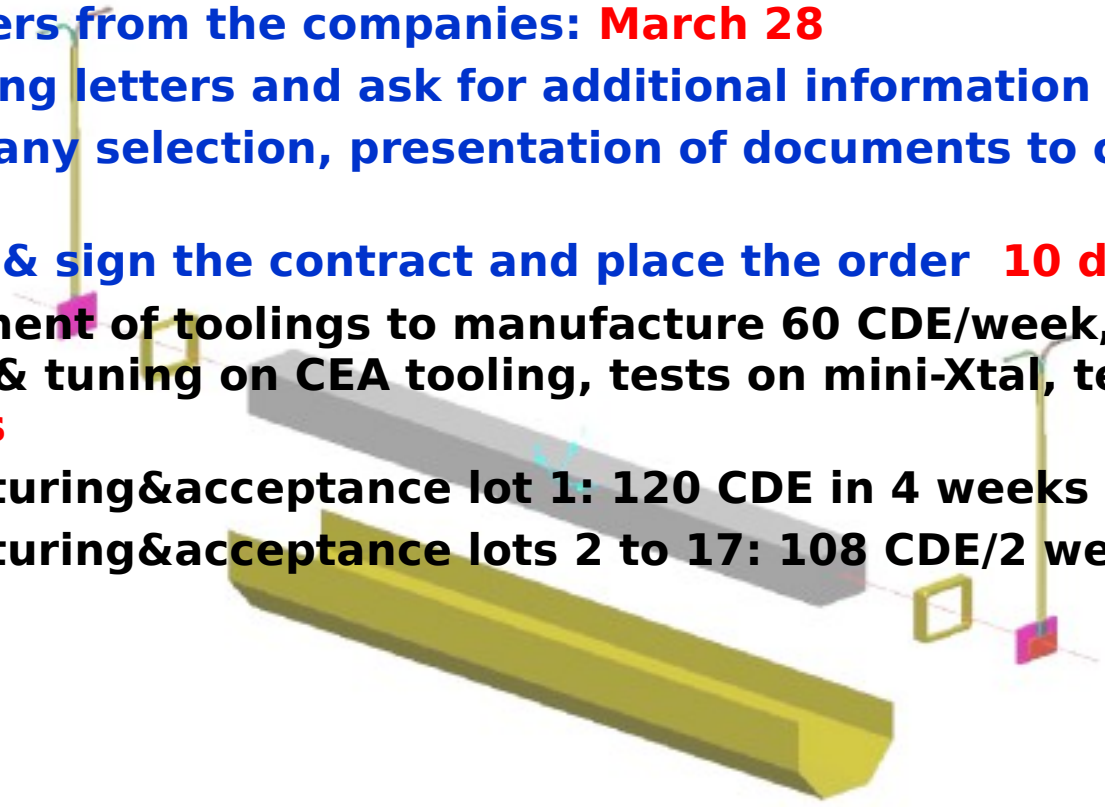




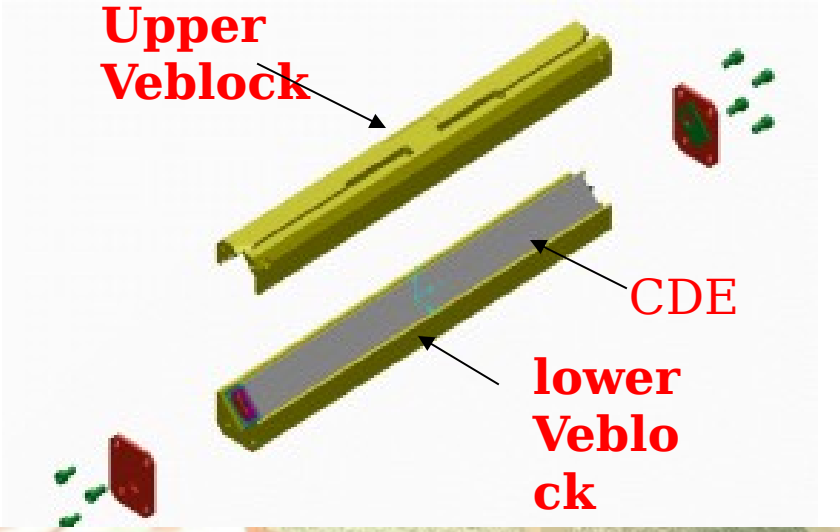
Wrapped CDE

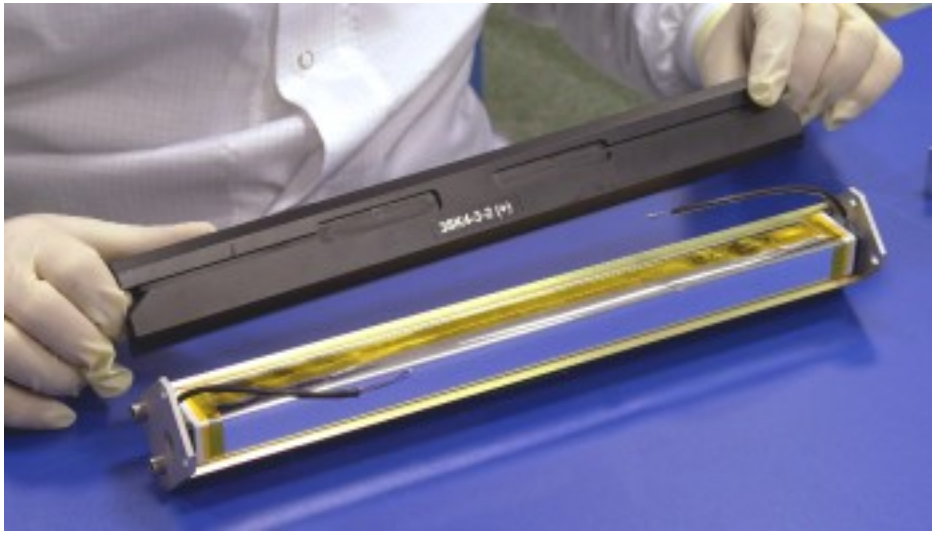
CDE manufacturing plan

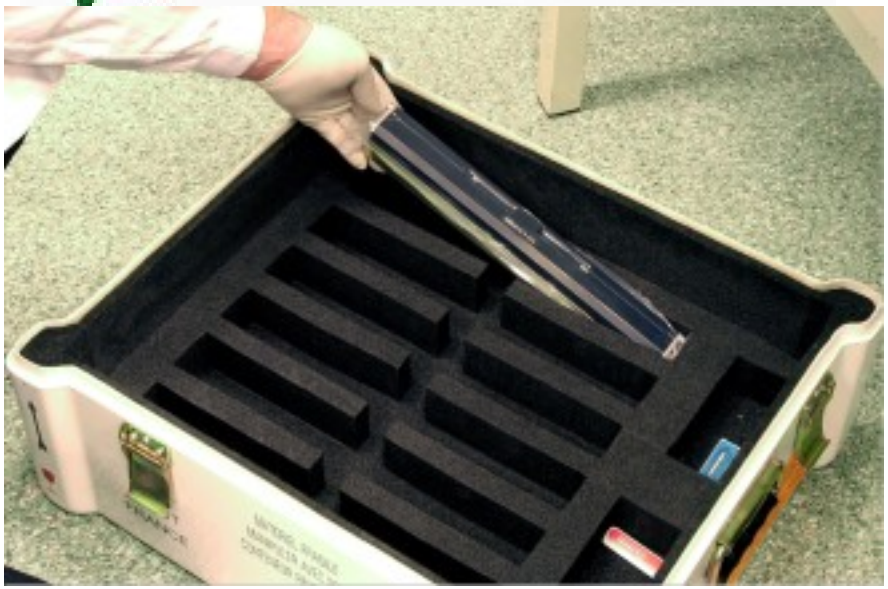
- Same manufacturer does bonding & wrapping
- Order foreseen May 26
  - Call for tender : done (6 companies interested)
  - Sending specifications to selected companies: done Feb. 13
  - Answers from the companies: March 28
  - Opening letters and ask for additional information < 2 weeks
  - Company selection, presentation of documents to comittee on 20 May
  - Write & sign the contract and place the order 10 days
- Procurement of toolings to manufacture 60 CDE/week, process practice & tuning on CEA tooling, tests on mini-Xtal, tests of 12 CDE: 3 months
- Manufacturing&acceptance lot 1: 120 CDE in 4 weeks in Sept
- Manufacturing&acceptance lots 2 to 17: 108 CDE/2 weeks Mid May '04



CDE packing & shipping





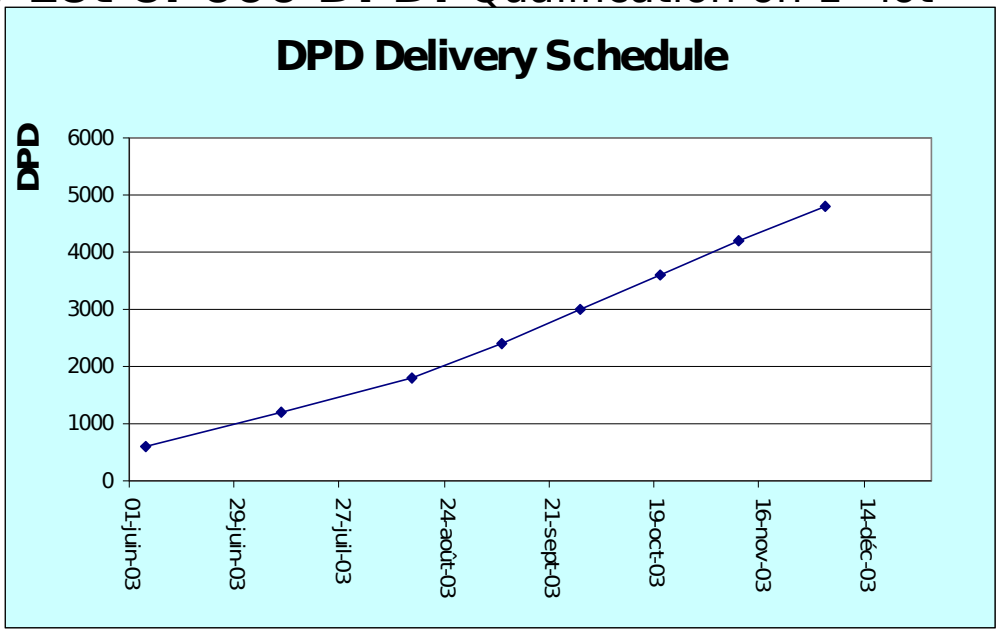


CDE System/Verification plan

- **EVALUATION: characteristics and margin studies**
  - **DPD S8576-01 (Silicone window, Lead tinning):**
    - 11 S8576 with Silicone encapsulant
    - 184 S8576-01 (DPD pre-FM-series)
  - **PDA (solder, staking, wires):** DPD pre-series
  - **Bonding (tooling, process):** DPD pre-series + mini Xtal
- **QUALIFICATION: Specification requirements**
  - **DPD S8576-01**
    - **Tinned ceramic:** 1% by lot
    - **Die:** 5 by wafer lot
    - **Assembly:** 10% 1rst Delivery Lot (+ screening)
  - **PDA (Plan TBC)**
  - **Bonding (tooling, process):** DPD pre-series + mini Xtal
  - **CDE :** DPD pre-series+ Xtal pre-series

DPD procurement status

- **New DPD version: S8576-01**
- **Order shared between NRL (5 lots) and CEA (3 lots)**
- **Order in place before evaluation (driven by schedule)**
- **Delivery of a pre-series:**
  - **184 with the silicone resin encapsulant**
  - **20 without encapsulant** (backup encapsulent study)
- **Delivery by Lot of 600 DPD:** Qualification on 1st lot



DPD Qualification plan

- **Philosophy:**
  - **Qualification on 1 lot associated to a screening**
  - **Qualification on 60 of 1st Delivery Lot in addition to its Acceptance test**
- **Main tests**
  - **Lead solderability** (1 DPD)
  - **Moisture intake (168h, 50°C, 50%RH)** (6 DPD)
  - **Steady-state life (1000h, 60°C)** (22 DPD)
  - **Thermal cycle (60c, -30 to 50°C)** (10 DPD)
  - **Radiation testing (10krad)** (3 DPD)
- **Associated control**
  - **Dark current & Green photosensitivity**
  - **Delamination, crack**
  - **Destructive Physical analysis**

DPD Acceptance Test (1)

- **Receiving inspection (with Hamamatsu representative)**
  - **Packaging and sensor inspections (shock, humidity, temp.)**
  - **DPD recorded parameters vs the acceptance limits**
    - **D.C., Capacitance, Sensitivity**
- **Control (within 2 weeks at CEA)**
  - **100% Visual inspection (window, leads)**

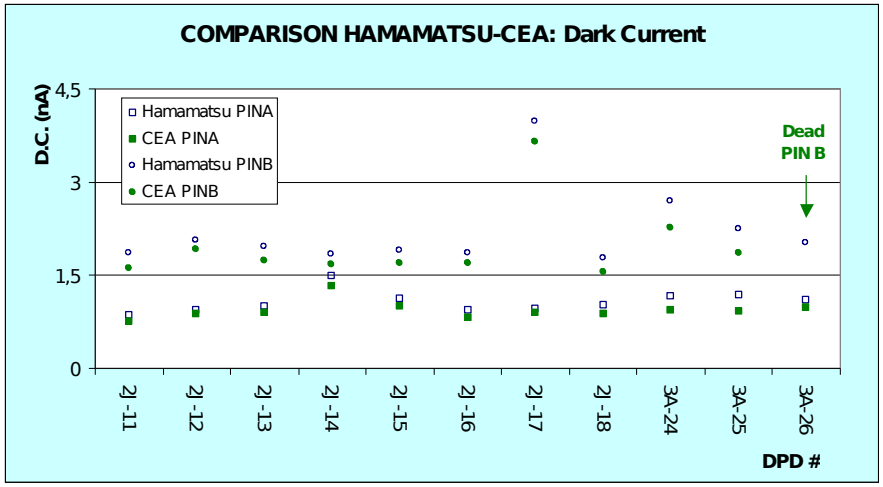
    ⇨ **refusal of bad DPDs**
  - **Sampling > 10% parameters (D.C., Capacitance, Sensitivity)**

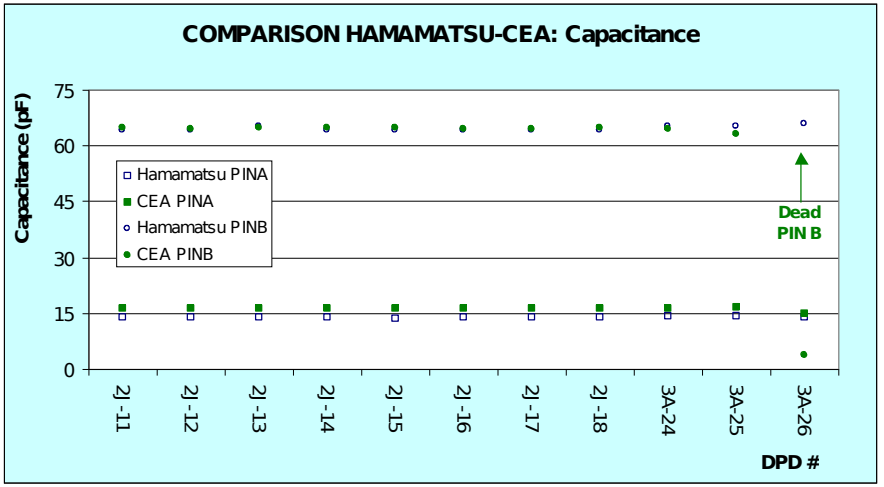
    ⇨ **Drift production monitoring**

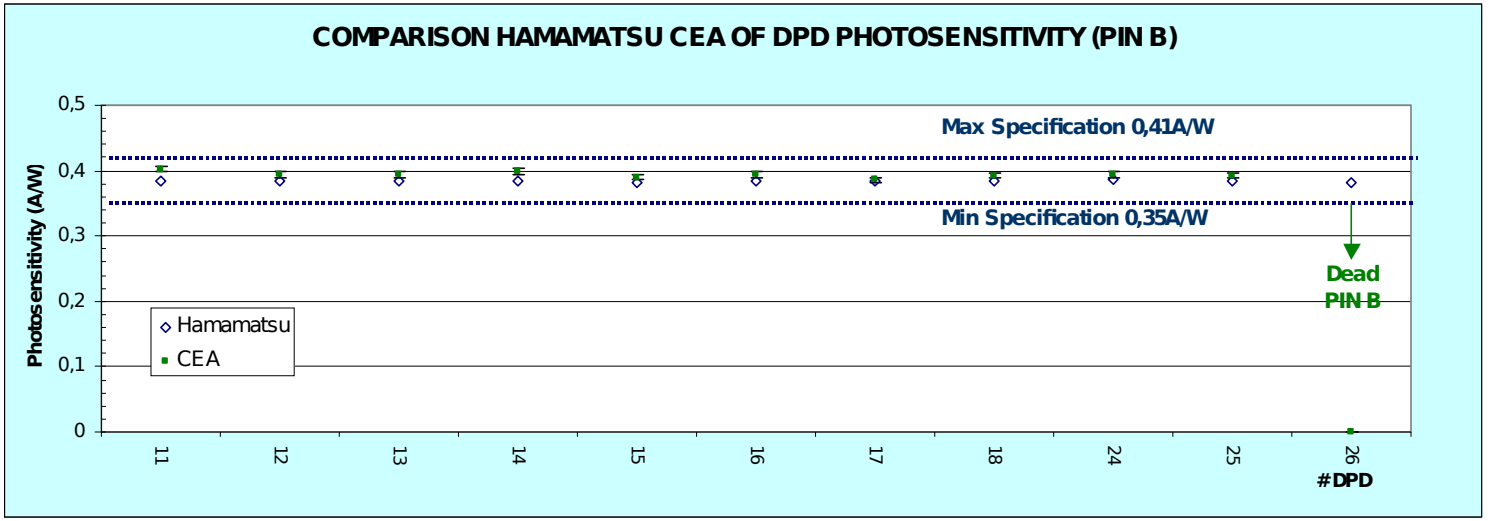
    ⇨ **Refusal of the delivery lot**

DPD Acceptance Test (2)

- **Acceptance test on the 11 DPD S8576 Silicone**







PDA design

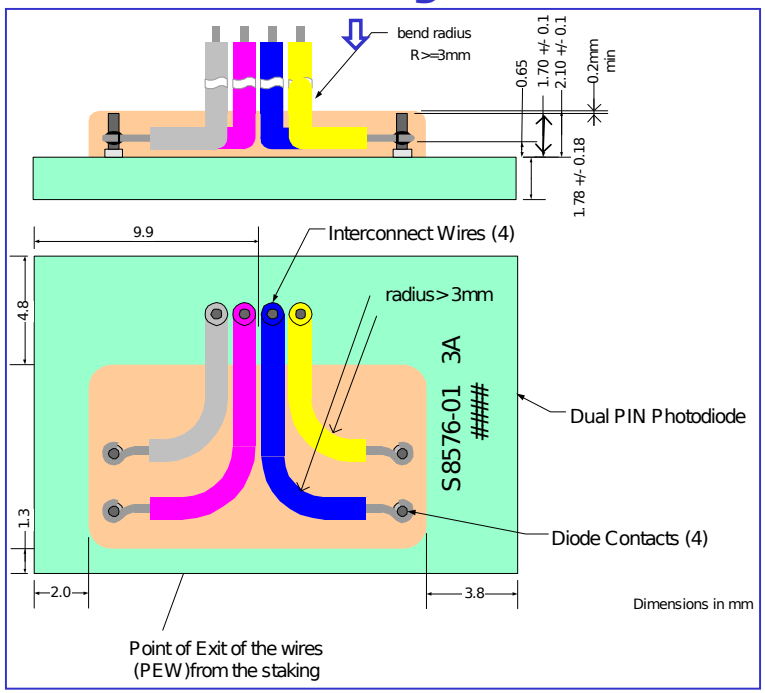
PhotoDiode Assembly: DPD + soldered wires + wires staking on ceramic

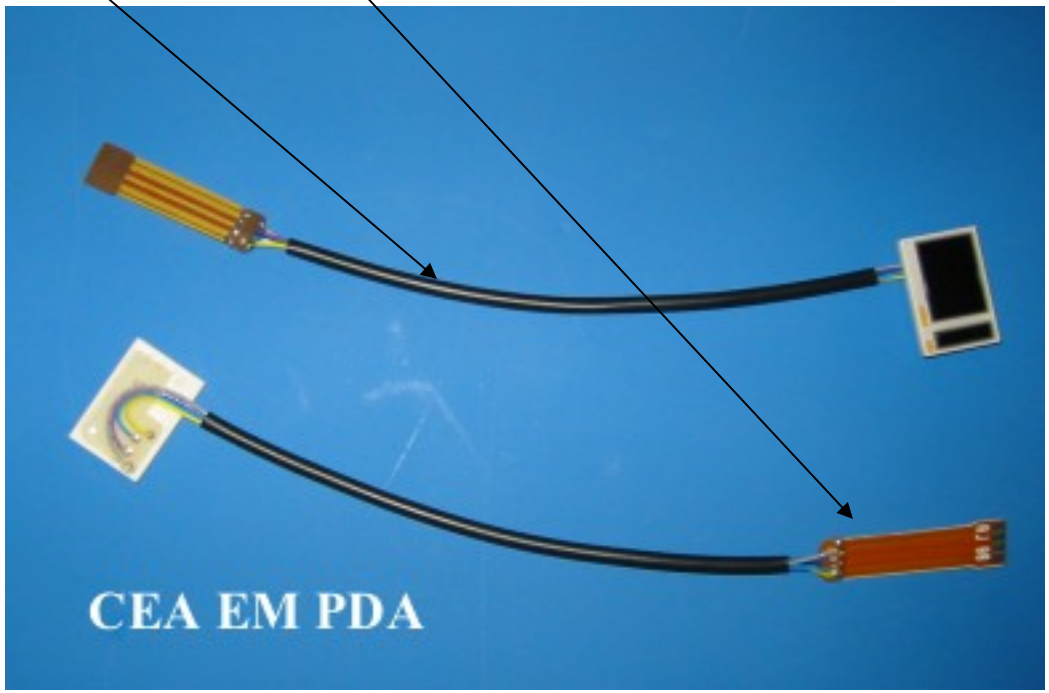
PDAfr: PDA + protective sleeve + connector for CEA test benches

New lead position of S8576-01

New staking mold

New c or





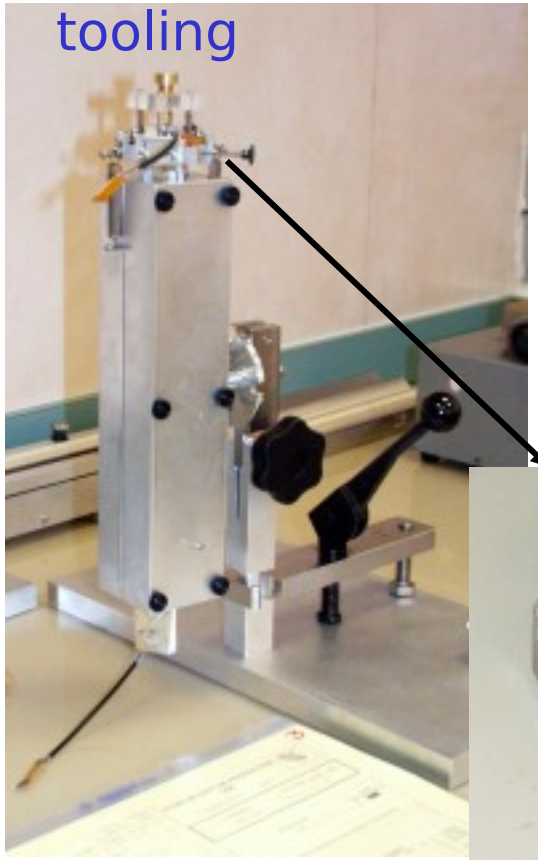
PDA verification plan

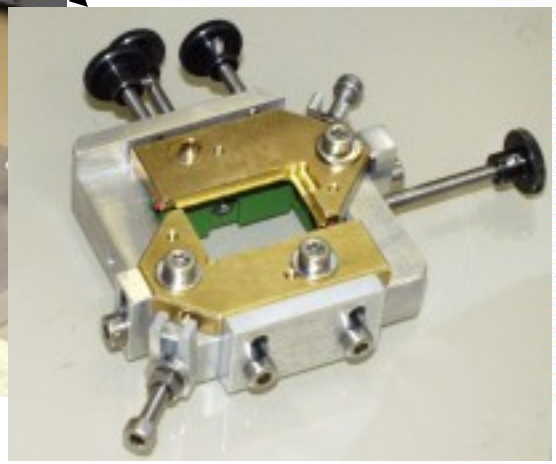
- **Evaluation:**
  - **Strength of the soldered and staked wires** (1kg requirement)
  - **New tinning (SN96Ag4 + 40°C)** study of DPD temperature when soldering
  - **Insulation of the 0.2mm staking above the leads** (0.1nA)
- **Qualification:**
  - **Spatial components (wires, encapsulant)**
  - **Spatial approve Subcontractor**
  - **Thermal cycle (60c, -30 to 50°C)** study of lead insulation on bare ceramic
- **Acceptance test:**
  - **100% Electrical** (D.C.)
  - **100% Visual** (Solder before staking,window)
  - **100% go-no go staking area**
  - **100% staking thickness**

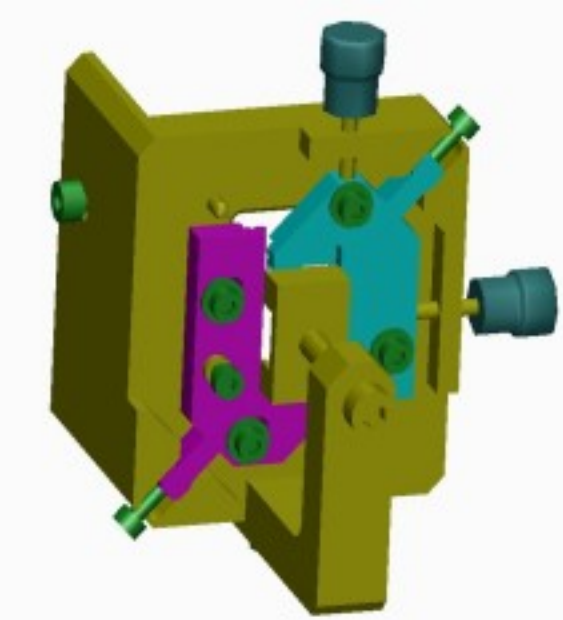
Bonding tooling design

- **Upgrade of the too**

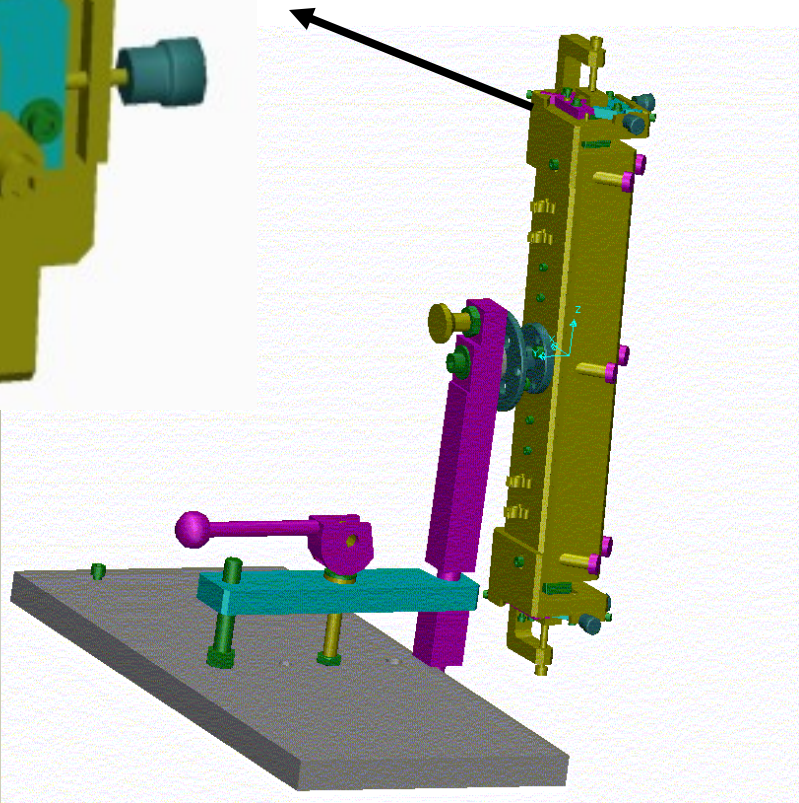
EM bonding tooling







FM bonding tooling



Bonding process verification

- **Sample: Mini Xtal + PDA at each end**
- **Evaluation:**
  - **Thermal Cycle** (-30 to 50°C, -38 to 60°C & -45 to 70°C, 30 cycles)
  - **Mechanical Test** (Shearing, shock, pulling)
  - **Optical test** (light yield)
- **Qualification:**

  1. Tooling and procedure
  - **Thermal Cycle** (-30 to 50°C, 0-30-60 cycles)
  - **Mechanical Test** (only Shearing)
  - **Optical test** (light yield)

  2. Sub-contractor
  - **Same plan**
- **Acceptance test:**
  - **2 samples every 100 bonding**
  - **100% Visual inspection** (bubble)

  ⇨ **repair allowed but PDA lost**

Wrapping foils inspection and testing

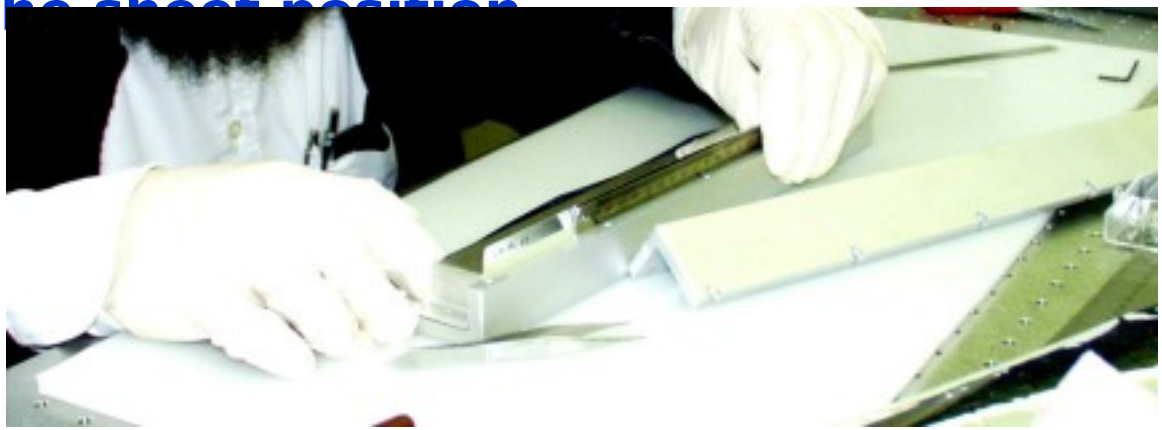
- **VM2000 roll Acceptance:**
  - **Reflectivity measurement**
  - **Wrapping of a reference CDE for L.Y. measurement**
- **VM2000 cutting Acceptance:**
  - **Clean room environment (Class 100,000)**
  - **Packaging by 12 sheets (with traceability)**
  - **1 sheet every 120 for L.Y. control on ref CDE**

CDE Wrapping Tooling design

- **Based on Swales design and procedure**

Upgrade of the molding tooling for a better reliability of the sheet position

VM2000 Mold tooling (120°C, 2h)



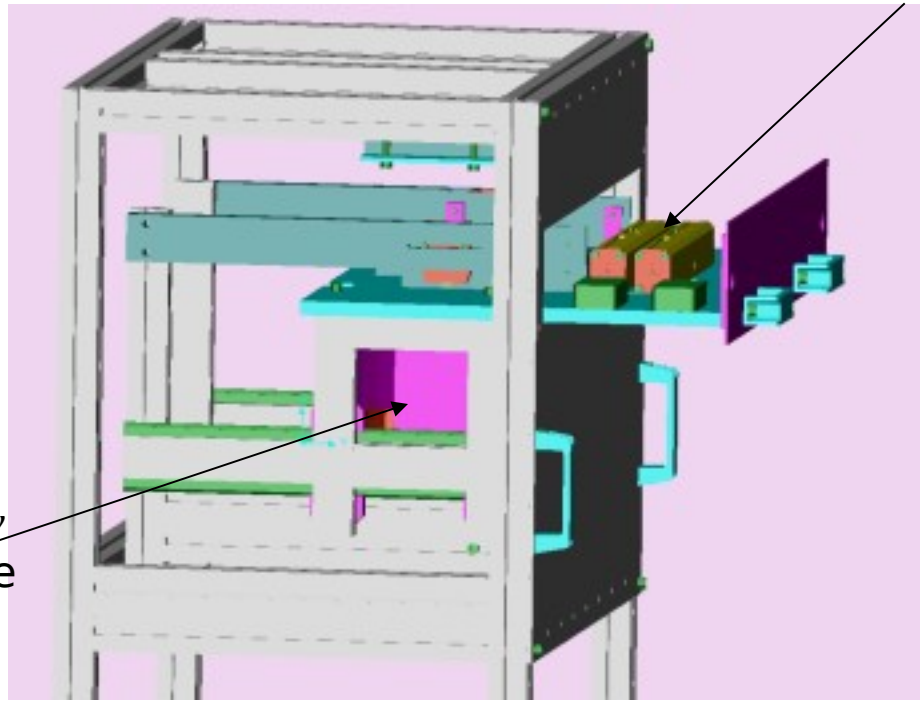
Industrialization of the Wrapping tooling

Wrappin
g tooling

CDE Verification Plan (1)

- **TEST at the subcontractor**
  - **100% mechanical control**
  - **100% PIN B L.Y. and resolution ; PIN B/PIN A ratio**

2 CDE at the time in their V support

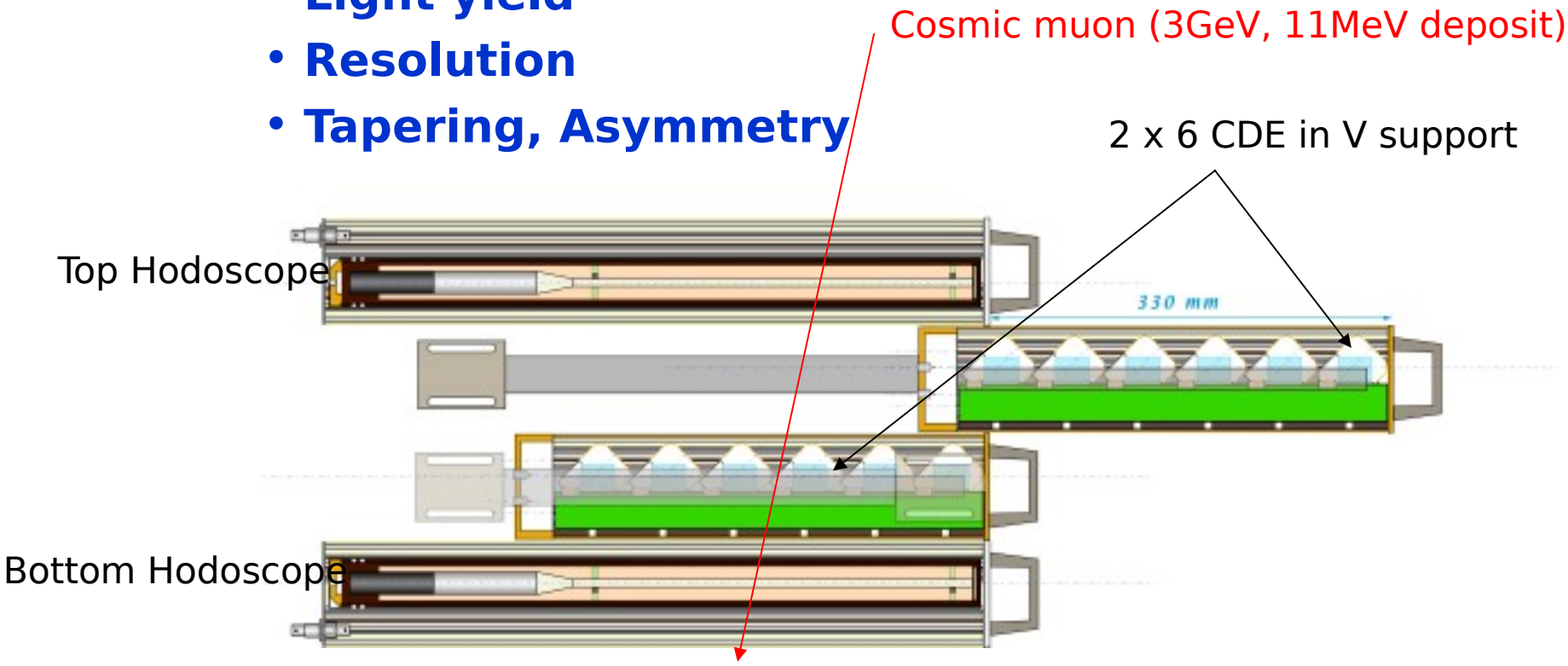


Yttrium 1.84MeV γ radioactive source

BIG (Banc Industrie Glast)

CDE Verification Plan (2)

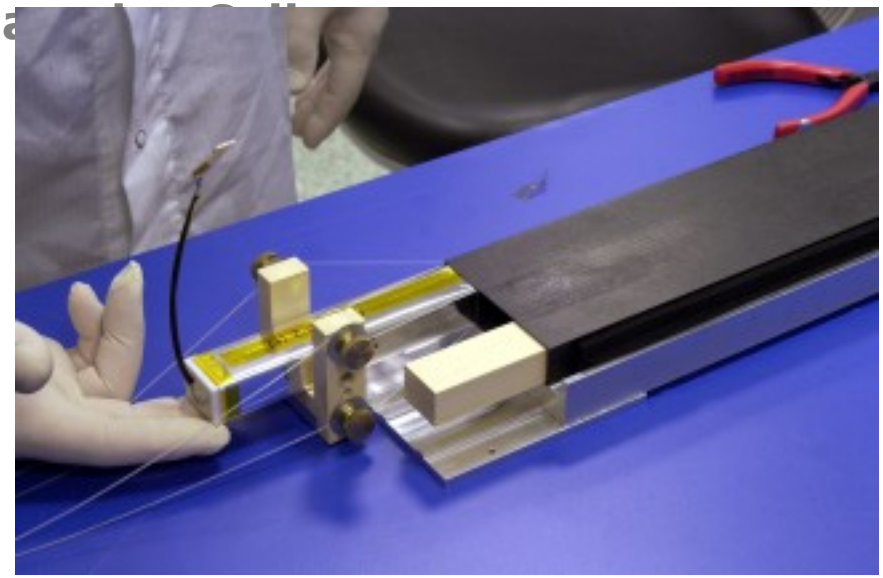
- **Performance measurements before shipping to NRL**
  - **For both PIN A & B:**
    - **Light yield**
    - **Resolution**
    - **Tapering, Asymmetry**



BCG (Banc Cosmiques Glast)

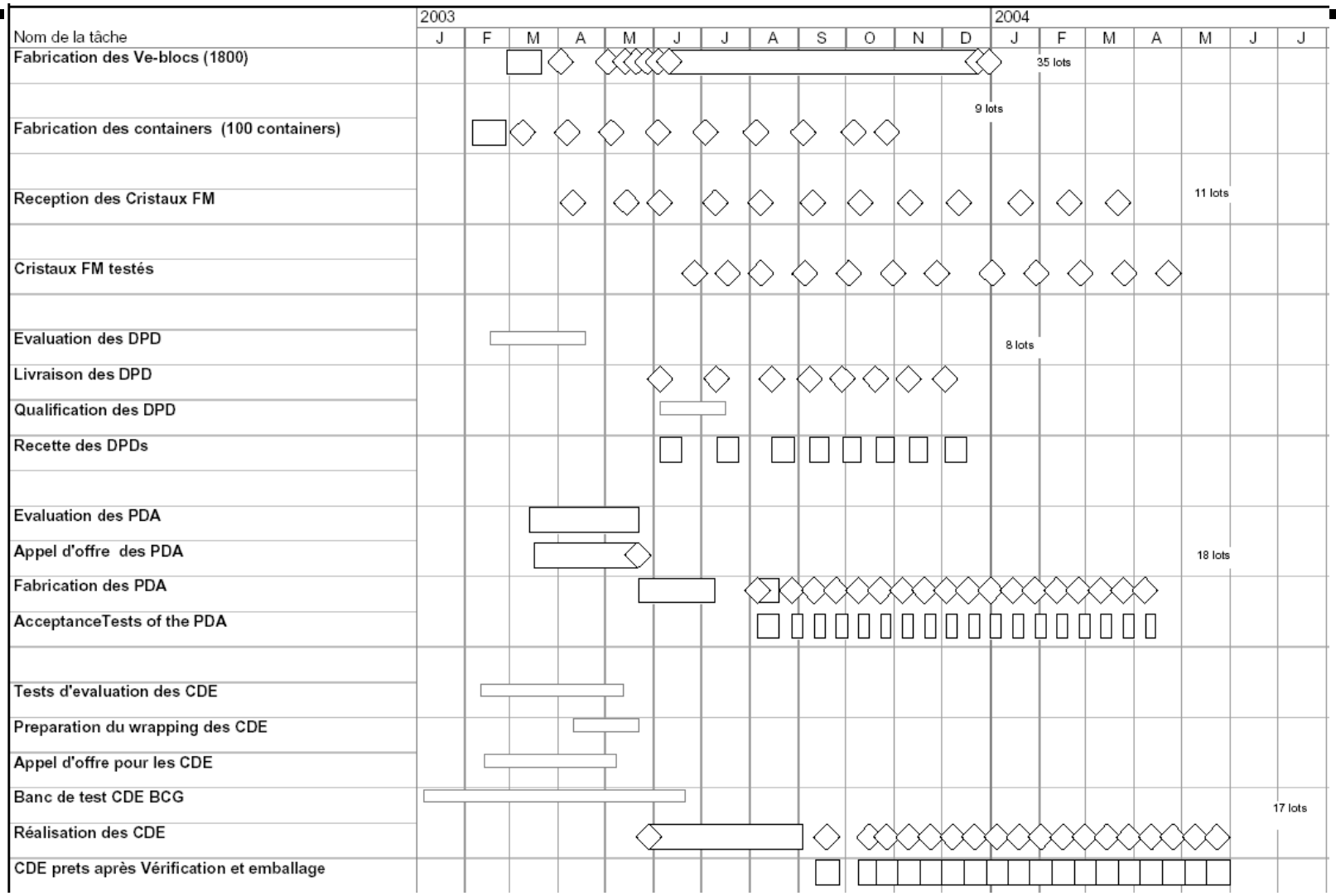
CDE Verification Plan (3)

- **Insertion test before shipping to NRL**
  - **Go no go: Minimum size Cell + 1mm cord stretched by a factor 2**
  - **If no go ⇨ Go-no go: Mea**
  - **Study of a two pieces Aluminium Alloy Cell**



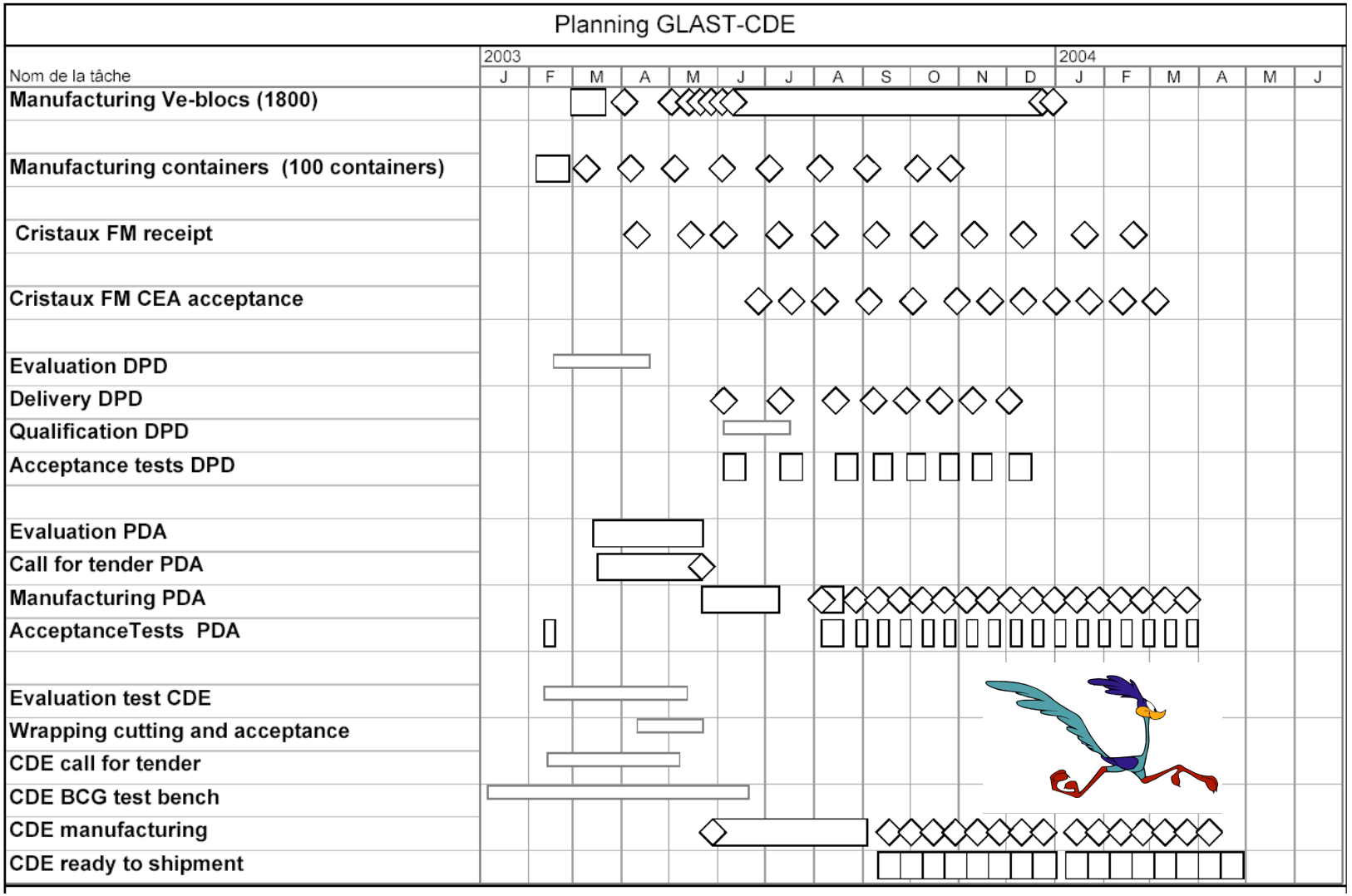
- **Qualification**
  - **Thermal Cycle** (-30 to 50°C, 0-30-60 cycles)
  - **Vacuum** (-1000mBar in 100s)
  - **Radiation test** (10kRad)

Current manufacturing schedule



Based on delivery at CEA of 184 eval DPD on April 14 and 1st FM DPDs on June 6

Increased rate schedule



Manpower & financial impact under study (60 CDE/week)

Schedule risks

- **Current schedule very tight**
  - **assumes successful DPD evaluation, PDA qualification, & bonding qualification**
  - **Market Committee Review (Budget Ministry & CEA) : if review requested ⇨ contract starting date could shift from May 26 to June 20 Mandatory**
  - **Manufacturers may be uncomfortable with 3 month preparation time and ask for 4 months known on March 31**
- **Increased rate schedule**
  - **Cost impact evaluated by March 31**
  - **Rate = 60/week ⇨ last CDE on time**
  - **Rate = 80/week ⇨ FM4 -16 on time**

Issues/Concerns

- New DPD evaluation
  - in progress on 10 samples
  - on some of the 184 DPDs starting in April
- DPD qualification on 60 DPD of lot 1 (= 600)
  - many manufactured by then ⇒ risk on schedule & cost
- PDA qualification of the soldering & staking
  - on some of the 184 DPDs starting in April
- Bonding qualification (concave silicon window)
  - tests at NRL, 4 being tested at Saclay, more in April
- Wrapping : VM2000 ESD properties
  - in progress at NRL and Goddard
- DPD packaging to be improved (in progress)
- No absolute light yield requirement on the Xtal, but on the CDE
  - Action: L.Y. acceptance tests of Xtals with DPD and sources